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MEDICINE[1]

By Professor J. F. FULTON, M.D.

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IT is at once a singular privilege and a heavy responsibility to address the undergraduates of Wesleyan College on the problems of a medical career, for a subject that is close to one's heart can not be discussed lightly, and he were foolhardy who would advise another concerning a life's work who had not weighed the matter judiciously and long. In the western part of the country where I was born we were taught as students that medicine and the church were the two highest callings to which a man might aspire, and if one were brought up in a doctor's family it required very little persuasion to convince one that ministering to the needs of the body was more important than caring for man's spiritual ills. Experience, however, indicates clearly that the two callings can never be wholly separated, for a man who has a true aptitude for the one generally finds himself responding to the needs of the other; and the son of a physician must be forgiven the prejudice that causes him instinctively to regard medicine as the highest of all callings.

Historically medicine and the church have been intimately related. The clergy at one time treated their devout followers for physical ills and there are many authentic records within historical times of monks and clergymen who were also doctors. Indeed, that great ecclesiastic of the eighteenth century after whom your college is named wrote one of the most popular books on medicine that was ever penned. John Wesley's "Primitive Physic; or, an Easy and Natural Method of Curing Most Diseases,"[2] which first appeared in 1747, passed through countless editions. I have here the thirty-second, which was published in London in 1828. The nature of his approach to the healing art may be gleaned by quoting a few sentences from his preface:

[1] An address to the premedical students of Wesleyan College, delivered at Middletown, Connecticut, on February 23, 1933.

[2] John Wesley, "Primitive Physic; or, an Easy and Natural Method of Curing Most Diseases." 32d edition, London, John Mason, 1828. xxiii + 162 pp.

When man came first out of the hands of the great Creator, clothed, in body as well as in soul, with immortality and incorruption, there was no place for physic, or the art of healing. As he knew no sin, so he knew no pain, no sickness, weakness or bodily disorder. . . .

But since man rebelled against the Sovereign of heaven and earth, how entirely is the scene changed! The incorruptible frame hath put on corruption, the immortal has put on mortality.

But can there nothing be found to lessen those inconveniences which can not be wholly removed, to soften the evils of life, and prevent in part the sickness and pain to which we are continually exposed?

It is probable, physic, as well as religion, was, in the first ages, chiefly traditional; every father delivering down to his sons what he had himself in like manner received, concerning the manner of healing both outward hurts, and the diseases incident to each season and climate, and the medicines which were of the greatest efficacy for the cure of each disorder. It is certain this is the method wherein the art of healing is preserved among the Americans [Indians] to this day. Their diseases, indeed, are exceedingly few; nor do they often occur, by reason of their continual exercise, and (till of late, universal) temperance. But if any are sick or bit by a serpent, or torn by a wild beast, the fathers immediately tell their children what remedy to apply. And it is rare that the patient suffers long, those medicines being quick, as well as generally infallible.

And has not the Author of nature taught us the use of many other medicines, by what is vulgarly termed *accident?* Thus, one walking some years since in a grove of pines, at a time when many in the neighboring town were afflicted with a kind of new distemper, little sores in the inside of the mouth, a drop of natural gum fell from one of the trees on the book which he was reading. This he took up, and thoughtless applied to one of those sore places. Finding the pain immediately cease, he applied it to another, which was also presently healed.

Thus far physic was wholly founded on experiment.

But he goes on to say that physicians in later days began to erect hypotheses, and simple experimental physic was no longer employed. Wesley therefore made a plea for the return to primitive pragmatic remedies—an excellent plea as far as it went, but, for obvious reasons, it would not fulfil all the needs of medicine. In 1760 Wesley also wrote an anonymous book on electricity under the title "The Desideratum: or, Electricity Made Plain and Useful."[3] This illustrates his wide interest in science and natural phenomena, and the book was frequently referred to by eighteenth century writers on electricity, including Priestley.

Within our own times there have also been distinguished examples of high officials of the church who have contributed to medical science or who have even practised the art. That versatile scholar of Baltimore, John Rathbone Oliver, priest of the Anglican church, doctor of medicine and a Greek scholar, is also a high authority on psychiatry and legal medicine. His book, "Four Square,"[4] a most remarkable human document, tells the story of his varied life in the clinic, the church, the courts and the university, and it carries this important message to any one who proposes to study medicine, that a man's success as a physician (or for that matter as a priest or minister) generally runs in proportion to his worldly experience. He must have seen life, and have seen it squarely. He should study with patience and sympathy every form of human emotion, and learn how at a glance to evaluate them. Age, sex, race and creed all bring human problems which fall within the immediate sphere of the physician. If he be Jew, let him learn to understand Gentile, if he be rich let him study the ways of the poor, if he be devout, let him inquire into the convictions of the pagan. Only through wide experience among all sorts and conditions of men can he gain that sense of security which will allow him to make those human contacts so essential for the successful practise of medicine. This, I think, is the great message that John Oliver has to offer to medical students, and I might remind you of his conviction that one of the most effective ways of increasing the intellectual horizon is by cultivating general literature. It is just as important to know how to approach the grave-digger of Hamlet as it is to "reach" Lady Macbeth or Nell Gwynne. The familiar grinning countenance of the immature, embarrassed youth bespeaks a lack of experience which counts heavily against any man who depends for his living upon an ability to inspire confidence in human beings.

All this is merely another way of stating that a man who wishes to prepare himself for medicine must become an active student of human nature. He must develop a degree of poise and reserve which will allow him to feel as much at home in a tenement as in a palace, and to be at ease with all the various groups and gatherings that constitute human society—Masons and Rotarians, trade unions and churches, senior proms and prize fights, fraternities and night clubs, etc. The instinctive poise so essential for meeting difficult social situations is most appropriately described by the Latin term *Aequanimitas,* and Osler,[5] who resurrected the word, was, like Dr. Oliver, never

[3] John Wesley, "The Desideratum: or, Electricity Made Plain and Useful. By a Lover of Mankind, and of Common Sense." London, W. Flexney, 1760. viii + 72 pp.

[4] John Rathbone Oliver, "Four Square." New York, The Macmillan Company, 1931. x + 305 pp.

[5] William Osler, "Aequanimitas. With Other Addresses to Medical Students, Nurses and Practitioners of Medicine." London, H. K. Lewis, 1904. vii + 389 pp.

weary of emphasizing that a knowledge of history, art and literature was the invariable touchstone that gave a man breadth of vision, human understanding and maturity of thought and action. For those who propose to go into medicine a little Greek tragedy, a few books of Rabelais, some Restoration drama, several good biographies, the "Ode to the Nightingale" and "David Copperfield" are as essential to sound preparation as text-books of chemistry, physics and zoology and the languages. In any medical school catalogue you will find bare requirements stated in terms of the biological and physical sciences, etc., but I would ask you to believe me when I say that these are probably not the most important requirements for a successful career in medicine. If these disciplines have trained you to observe accurately, to describe clearly and objectively the things you have seen, and finally to draw logical inferences on the basis of closely reasoned arguments, your physics and chemistry will have been of some use. A careful training in mathematics, geology or astronomy or, even in economics, might enable you to do the same thing, and they would fit you almost as well for the study of medicine. No medical school catalogue that I know of emphasizes the value of general literature and worldly experience as a prerequisite for medical students. But in my opinion these broader disciplines transcend in importance the stated requirements in languages and the sciences. I can perhaps make this point clearer by describing more specifically certain aspects of the training of a physician which I propose to do under the headings of "The Art" and "The Science."

I. THE ART

In the year 1543 an indefatigable, black-haired man of 28 years of age published a book which marks the dawn of modern medicine. In the preface of the book he made the pregnant remark that training of the hand is the most important part of the training of a physician. Taken out of its context the statement may seem bald and meaningless, but it contains a truth as important to-day as it was in the time of Andreas Vesalius, who first gave utterance to it. Vesalius protested that physicians of his day had forgotten how to use their hands, that they had refused to dissect the human body and had relegated to ignorant and artless barbers the operations of surgery and to others, still more ignorant, the task of dispensing drugs. Vesalius felt in his soul that this was wrong, and to prove his point he began at the early age of 21 to rob graves, unstring criminals from the gallows, that he might determine for himself the structures of the human body. Hitherto such dissections as had been performed were carried out by servants at the behest of a professor who declined to soil his fingers by touching decaying human flesh. Within a few years Vesalius had dissected all parts of the human body with his own hands and had written his great book, "De Humani Corporis Fabrica."[6] Quite apart from the gigantic character of his labor and the fact that the book created human anatomy as we now know it, it had a subtle influence which gradually permeated the whole field of medicine. It was an influence which emanated, not from any new truth that he propounded in the book itself, but from the example he had set. Great teaching comes not from lectures or from books, but from example, and that a man of 28 could have achieved what Vesalius achieved, through industry and training his hand to obey his will, has given inspiration to all students of medicine since his time.

In evolutionary history the cultivation of the hand in dextrous performance has undoubtedly been one of the chief stimuli for the development of the brain. The animal which was quick and alert, using all its motor cells to fullest capacity, was more likely to survive than the animal who allowed these cells to retrogress through inactivity. And I have always had the belief, but of course it can not be proved, that in the development of the individual, constant use of the hands in skilful maneuvers is a great stimulus to intellectual activity. When, therefore, I tell you that a large part of the training of a physician consists in teaching him to use his hands, I do so believing that this is one of the chief factors underlying intellectual development. The student is given the opportunity to perform many of the classical experiments in physiology, all of which involve delicate manipulation. He is also called upon to dissect the human body, following nerves and vessels to their finest ultimate ramifications, an enterprise that calls for patience, delicacy of movement and indeed a degree of manual skill considerably more precise than is commonly appreciated. The hands are further trained in the wards and the surgical amphitheater. The tips of the fingers come to appreciate the physical signs of disease in chest and abdomen, the delicate variations of the pulse and many other things peculiar to the practise of internal medicine. Similarly, surgery is essentially a field involving the skilled eye and the trained hand, which, closely interacting with one another, allow the development of that most precious of all attributes, sound surgical judgment.

I do not wish to belabor the Vesalian aphorism concerning the training of the hand, for it means very little in the absence of the other great parts of the art of medicine alluded to in my introductory re-

[6] Andreas Vesalius, "De humani corporis fabrica." Bale, 1543. 6 11. 660 pp. 17 11.

marks. In a rapidly changing world one dislikes to commit oneself concerning the future of a great profession, but certain trends are already clear. One is that in America medicine has been divided into too many unintegrated specialties. Vesalius believed that a man whose hand is trained can practise the whole art of medicine; he can diagnose, he can treat (surgically, if necessary) and he can make his own drugs. In most large cities at the present time the heart specialist refuses to see anything but cardiac cases, and is quite unable to cope, for example, with an acute infection. The general public have already rebelled at this state of affairs and are looking more and more for the man who will assume responsibility for their general health, in short, for the old-time general practitioner, or perhaps one should say, for the "new-time" general practitioner. This feeling of dissatisfaction in the present status of medical care has become acutely evident in the recent and much discussed report on "The Costs of Medical Care."[7] The distinguished committee responsible for this report have made certain recommendations concerning socialization of medicine with which many conservative people do not agree. They have nevertheless put their finger on one crucial difficulty, namely, that well-trained general practitioners have become too few. Upon this point all, or practically all, are in agreement, but it is very difficult to attract well-trained men into general practise, for the specialties have tended in the recent past to be more lucrative and more satisfying to those whose minds have been trained in a strictly scientific mould. Furthermore, many schools have experienced difficulty in giving the student contact with the vital social, economic and family problems which form an essential background for general practise. Since in the past many of the weaker students have entered general practise the quality of medical care has tended to be inferior. General practise requires men who, as my colleague Dr. Blake has aptly put it, are "sympathetic, scientific, skilled and studious," and one might add that a man who is not studious by nature is certain to fall behind in the rapidly advancing front of medicine.

The Science

As my own sphere of work lies primarily in the laboratory it might be expected that I would speak more enthusiastically of the science of medicine than of the art, but this is not quite the case, for I firmly believe that real success comes only through union of the two. A student may ultimately settle down primarily in the one atmosphere or in the other: he may practise or he may investigate, but to do either one effectively requires the broadest possible comprehension of what constitutes science, and of what men live by.

The science of medicine has reference to the analysis and interpretation of normal and pathological processes of the body in terms of physical and chemical laws (in so far as this is possible) with the end in view of instituting sound therapy. Physiology embraces the scientific study of the normal functions of the body. The term "physiology" is derived from a Greek root with the Latin equivalent *Physiologia*.[8] The word was used in classical times to signify all natural knowledge, *i.e.*, physics, zoology, astronomy, etc., but towards the end of the eighteenth century the Latin word and the English equivalent came to be restricted to include only biological knowledge, and in the nineteenth century physiology was defined as that branch of science which treats of the application of the laws of physics and chemistry in the study of living things. To understand the way in which oxygen passes from the inspired air into the blood, one must be familiar with the gas laws, especially in relation to the principle of partial pressure; similarly, a knowledge of osmotic pressure is essential for an understanding of the functions of the kidney. In clinical medicine, where the attempt is made to analyze and correct the derangements of function, the physico-chemical interpretation of bodily activities is tacitly accepted. The physician, on being confronted by signs of derangement, attempts to analyze them in the simple terms, in order to arrive at a diagnosis. The symptoms of the disturbance constitute his evidence, and after they are fully described, he attempts by a careful process of logical analysis, similar to that used in the solution of any scientific problem, to reach a conclusion as to what organ or what system of organs is functionally deranged. He has finally to institute methods which will, if possible, restore the body to its normal state. Every stage in the process of making the diagnosis, and of prescribing therapy can be regarded as a strictly scientific procedure. Indeed, the patient can with some justification be looked upon as a more or less complex machine with some parts broken that must be repaired. The chief task of a physiologist, therefore, is to train students during the first years of medicine to think clearly and logically, and the more training they have in this direction before they come the more rapid will be their progress.

It might be assumed, and indeed it often is assumed, that the science of medicine is the only thing that matters, and that when the laws of physics and chem-

[7] Committee on the Costs of Medical Care. "Medical Care for the American People. The Final Report of the Committee on the Costs of Medical Care." Chicago, University of Chicago Press, 1932. xvi + 213 pp.

[8] J. F. Fulton, "A Note on the Origin of the Term 'Physiology.'" *Yale Jour. Biol. Med.*, 3: 59–62, 1930.

istry as applied to the body come to be more clearly understood, the human element in medicine will become less and less important. To a certain extent this is true, but so long as human beings are what they are, the need for the art coupled with the science is only too manifest, especially when one is called upon to deal with spiritual and mental ills.

From the point of view of a prospective medical student it is desirable to consider what medicine has to offer, on the one hand, to a man who wishes to devote himself purely to research, *i.e.*, to academic medicine, and, on the other, to a man who wishes to practise and hopes nevertheless to advance his chosen profession.

For the laboratory investigator there are three chief openings, (1) study of normal form and function, (2) the causes and characteristics of specific disease entities, and (3) the means by which diseases may be prevented, ameliorated or cured. It is unnecessary to discuss all three in detail, but I can perhaps give you some idea of the scope of the first by describing the work now going on in my own department (physiology), for of this I can speak at first hand. My colleague, Professor Hitchcock, a pupil of Jacques Loeb, who acts as head of a division of the laboratory known as general physiology, concerns himself with the study of the physicochemical properties of protein solutions and with the principles of physical chemistry. Dr. Himwich is in charge of another separate division in which the blood gases are studied as well as the mode of utilization by the body of its various foodstuffs (metabolism). Associated with Dr. Himwich is a former Wesleyan man, Nathan Rakieten, who has made a series of interesting studies on the effect of alcohol on metabolism. The other members of the laboratory are studying the comparative physiology of monkeys and the higher apes. Many have been conscious of the fact that it is impossible to infer from studies of the lower forms of animals, such as cats and rabbits, the functions of higher forms. Much is to be gained from the analysis of homologous functions in animals representing various stages of evolution; thus the stomach or the brain of the cat is quite different from that of a monkey, and in a monkey different from that of man, but the chimpanzee closely approaches the human being in every faculty except that of speech, and it is obvious that physiological studies carried out upon the chimpanzee carry much greater significance than corresponding studies made upon lower forms. We are therefore working intensively with chimpanzees, training them to perform various highly complicated manipulations—much as we do our medical students—and we then proceed to study the effect on the animal's memory of the skilled acts of removal of various parts of the brain.

I would like to remind those who propose to practise medicine of one important fact, that they may advance scientific medicine as effectively, and perhaps even more effectively, than a laboratory monk, such as I am, who devotes his attention wholly to animals and first-year medical students. Some years ago I had occasion to edit a volume of "Readings in the History of Physiology,"[9] in which the attempt was made to bring together the original description of the great discoveries in the history of our science. About 75 selections were made, and it was very surprising to discover, on analyzing the materials, that 14 of the discoveries were based upon human experimentation—in most cases upon experiments carried out upon the discoverer himself. Spallanzani, for example, swallowed perforated metal pellets containing food and on ultimately recovering them observed to what extent the food had been digested; Haldane and Priestley discovered on themselves how the gas, carbon dioxide, stimulates the breathing center in the medulla. These instances might be multiplied. Any student who observes his patient carefully, keeping detailed records of what he sees, and who ultimately analyzes his observations in a scientific spirit, is likely at any time to make an important contribution to scientific medicine. Indeed, there are many instances in the recent annals of medicine of men who have made their contributions solely from the study of patients. One might cite, for example, the great French neurologist, Joseph Babinski, who died only a few months ago. In describing his career to a group of medical students in New York I pointed out that it had this message to offer:[10]

> He gave himself the broadest possible training in general medicine before he came to specialize. He chose as his mentors the best clinical teachers then to be found in France and he remained loyal to them until his death. His scientific achievements were based entirely upon the study of clinical material. Painstaking observation and study, coupled with an alertness of mind that allowed nothing to escape him caused Babinski to see far more deeply into the mysteries of the nervous system than most men who have had the advantage of the experimental approach to the subject. And it is a curious fact that in most of his papers Babinski was silent about relevant work from physiological laboratories. There is, of course, ample evidence that he was familiar with the experimental literature, but he clearly did not regard laboratory experimentation as essential for a career as a scientific clinician. Had he been an experimentalist he might have gone even further, but those who wish to

[9] J. F. Fulton, "Selected Readings in the History of Physiology." Springfield, Ill., Charles C. Thomas, 1930. xx + 317 pp.

[10] J. F. Fulton, "Science in the Clinic as Exemplified by the Life and Work of Joseph Babinski." *Jour. Nerv. Ment. Dis.*, 77: 121–133, 1933.

emulate him in the field of medicine will do well if they achieve as much as he, and for them Babinski leaves the memory of a great name and the inspiration of a great example.

CONCLUSIONS

If those who propose to study medicine have not yet decided whether research or practise attracts them most it is well to realize that scientific medicine in this country has been made attractive by a number of unusual, and probably artificial, circumstances. The munificence of certain individuals and of scientific foundations has made it possible for large numbers of men to devote their lives purely to biological science. For reasons which are only too obvious to any one who has studied the present world situation it is unlikely that the numbers of those who are able to pursue such research will increase; indeed, their numbers are likely to diminish sharply. There is no doubt, furthermore, that schools and universities of this country have trained far too many men who intend to devote their lives to research alone. Unless a man's aptitudes are of a very extraordinary character, or unless he is financially independent, it is far wiser for him to begin the study of medicine with the intention of entering practise, if possible, general practise. In so doing he will be in daily contact with the major problems of disease and if he brings to this task a well-trained mind, as well as broad and sympathetic understanding of human problems, he will be able to make, as other illustrious physicians have made before him, discoveries and contributions which will advance our common science. If, like John Wesley, he is a pragmatist, willing to try anything within reason, and holding fast only to that which is good, he may make discoveries which in the present state of knowledge he can not explain, but he will at least have the satisfaction of realizing that he has benefited one and perhaps many suffering human beings, and he may take even greater satisfaction in knowing that he has handed to his intellectual descendants of the next generation the stimulus of his achievement.

Finally, medicine has a good deal of the spirit of the guild with a strong tradition and consciousness of its continuity with the past. Many therefore resent the tendency among writers of the present generation to make light of the foibles of the men who early attempted to cope with disease. Kipling, with characteristic insight, sums up the spirit of medical tradition in his poem "Our Fathers of Old,"[11] which incidentally offers a healthy corrective for those who have not caught the spirit of continuity and loyalty that characterizes medicine.

OUR FATHERS OF OLD

Wonderful little, when all is said,
  Wonderful little our fathers knew.
Half their remedies cured you dead—
  Most of their teaching was quite untrue—
"Look at the stars when a patient is ill,
  (Dirt has nothing to do with disease,)
Bleed and blister him as oft as you please."
    Whence enormous and manifold
    Errors were made by our fathers of old.

Yet when sickness was sore in the land,
  And neither planet nor herb assuaged,
They took their lives in their lancet-hand
  And, oh, what a wonderful war they waged!
Yes, when the crosses were chalked on the door—
  Yes, when the terrible dead-cart rolled,
Excellent courage our fathers bore—
  Excellent heart had our fathers of old,
    None too learned, but nobly bold
    Into the fight went our fathers of old.

If it be certain, as Galen says,
  And sage Hippocrates holds as much—
"That those afflicted by doubts and dismays
  Are mightily helped by a dead man's touch,"
Then, be good to us, stars above!
  Then, be good to us, herbs below!
We are afflicted by what we can prove;
  We are distracted by what we know—
    So—ah so!
    Down from your heaven or up from your mould
    Send us the hearts of our fathers of old!

—*"Rewards and Fairies."*

EURYPTERID INFLUENCE ON VERTEBRATE HISTORY

By Professor **ALFRED S. ROMER**
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THE general history of skeletal development in vertebrates was assumed until recent years to be a simple one. Since cartilage develops before bone in the embryo, and since the most primitive of living vertebrates have no bony tissues, it was believed that the phylogenetic story was similar—that the main line of early vertebrate evolution, as far as the stage represented by the highly developed bony fish, lay through a series of forms possessing a purely cartilaginous skeleton and lacking dermal defenses other than the shark type of denticles. The lamprey and

[11] Rudyard Kipling, "Rewards and Fairies." New York, Doubleday, Page and Company. 1925. xii + 344 pp.

the shark were thus believed to be primitive cartilaginous types. We knew that certain early groups, such as the ostracoderms and arthrodires, possessed a hard external armor, in many instances containing true bone; but it was generally assumed that they were aberrant forms which had separately attained this condition and that they had nothing to do with the main line of vertebrate descent.

Recent discoveries and investigations, particularly those of Stensiö, have tended strongly to show that the truth lies almost in the opposite direction—that bone is an exceedingly old structure in vertebrate history, and that living cartilaginous vertebrates are not primitive, but degenerate, as regards their skeletons. In many fish groups it is definitely known that skeletal degeneration has occurred, and the new evidence renders it probable that such degeneration has been a general trend in fish history. Stensiö[1] has brought forward convincing evidence of the descent of lampreys from Paleozoic forms with a bony skeleton; there is a growing body of evidence suggesting that the sharks have been derived from armored types[2]; even among the higher fishes degeneration has been at work, for only three living genera (the garpike and two African forms) retain the thick squamous armor of their Devonian ancestors, and many primitive existing types (lungfishes, sturgeons, paddle-fishes) are degenerate in their internal skeleton as well. Lower Devonian and Silurian vertebrates, as far as known, are invariably armored, and bony plates are present in the Ordovician forms known from fragments from the Harding Sandstone of Colorado. Bone is thus an ancient tissue. It now seems highly probable that the oldest vertebrates early acquired a hard external armor, which has been reduced or lost by most later groups.

Why was armor present in the early vertebrates? Its seeming universal presence can not well be considered an "accident" in evolutionary history. The later Professor Patten ably argued that the hard exoskeleton was an inheritance from the eurypterids, which he believed to be their ancestors, but recent detailed work on the structure of the older vertebrates fails to support the claim for a genetic relationship of the two groups. It has been suggested that the armor might have served as a protection against buffeting on rocky surfaces in fast flowing streams. But modern fishes in such environments seem to survive without such elaborate protection; and the frequent presence of spines and projecting "horns" in the earlier types would have tended to an increase in such encounters rather than to their avoidance. The only reasonable explanation is that the armor was a protection against living enemies. The presence in *Cephalaspis,* an ancient Silurian vertebrate, of presumed electric organs analogous to those of certain modern fishes, tends to confirm this assumption.

Against what enemies were the early vertebrates protected? Modern forms are usually armored in relation to escape from their own carnivorous vertebrate relatives. But in Silurian times none of the adequately known vertebrates possessed any hard biting jaws capable of rendering a predacious existence possible. The enemy must be sought among the invertebrate types.

At first one thinks of the larger marine invertebrates, such as the cephalopods. But the environmental surroundings of early vertebrates must be taken into account. Increasingly our fossil evidence tends to confirm T. C. Chamberlin's theory of the freshwater origin of vertebrates. The higher bony fish are definitely known to have been almost without exception inhabitants of fresh waters when they appear in Middle Devonian times, and only later invaded the seas. The oldest sharks known are fresh-water forms. The known Silurian vertebrates are found in deposits which appear to be either of fresh-water origin, or, at the most, brackish. The Ordovician remains previously referred to are believed to have been those of stream-dwelling types.

Among invertebrates there is one group, and only one, in which a similar environmental history is known, the eurypterids, an ancient, extinct group of large aquatic scorpion-like Arachnids, of which the modern horseshoe crab, *Limulus,* is the nearest surviving relative. Their habitat has been much debated, but it is now generally agreed that during the later part of their history, at least, the eurypterids, in contrast to most of the older invertebrates, inhabited fresh waters.[3] Although dating back at least to the Cambrian, the eurypterids became common only in the Silurian, reaching a climax in size and abundance toward the end of that period. In the Devonian they rapidly declined, and survived only in limited numbers to the Permian, when they disappeared.

The eurypterids, with biting mouth parts and grasping jaws, were seemingly predaceous types, as are practically all arachnoids. They tended to large size, reaching as much as nine feet in length in one genus; on the other hand, the early vertebrates were comparatively small, the average Silurian form being but a few inches in length. The vertebrates thus appear to have been an appropriate food possibility for the

[1] "Skrifter om Svalbard og Nordishavet," No. 12, Norske Videnkaps-Akademi i Oslo, 1927.

[2] Stensiö in Field Mus. Nat. Hist. Publ. Geol. Vol. 4, 1923, pp. 89–198, and Smith Woodward in Livre Jubil. Cinquant. fond. Soc. Geol. Belgique, 1924, pp. 59–62.

[3] M. O'Connell, in *Bull. Buffalo Soc. Nat. Hist.*, Vol. 11, No. 3, 1–277, 1916; *cf.* R. Ruedemann, in *Amer. Jour. Sci.*, Vol. 7, pp. 227–232, 1924.

eurypterids. This possibility is strengthened by the fact that in almost every one of the localities of late Silurian and early Devonian age in which the earliest vertebrate faunas are found, eurypterids were also present, but almost no other invertebrate types are preserved with them. Such localities include, for example, the Shawangunk grits of New York, the Lower Devonian of the Maritime Provinces of Canada, the Ludlow and Downtonian of England and Scotland, the Downtonian of Norway, the Upper Silurian waterlimes of the Baltic and the Old Red Sandstone of Scotland. Eurypterids and vertebrates actually inhabited the same waters. Apart from the vertebrates little source of food supply is evident for the eurypterids.[4] Except for the eurypterids there is no obvious enemy against which vertebrates needed protection.

This hypothesis fits adequately many facts in the history of these two groups of organisms.

Two apparently unassociated facts in their history may be noted. (1) The eurypterids, as has been said, appear to have reached a maximum in size and numbers at about the end of the Silurian. Following this they rapidly declined into insignificance during the Devonian. (2) While all known early vertebrates were superficially well armored, a rapid increase in unarmored forms and a strong tendency for the thinning out and loss of dermal defenses appears to have been initiated during the Devonian.

It appears probable that these two phenomena are related and are explicable by a consideration of certain other characteristics of Devonian fish history. (a) During the Devonian there is a tendency toward a considerably greater average size in fishes. (b) Many forms, particularly shark-like types, appear to have been migrating from fresh into marine waters. (c) Although Silurian ostracoderms were almost universally depressed-shaped and obviously slow-moving forms, the Devonian fish fauna is characterized by the appearance and dominance of much faster-swimming types, the acanthodian sharks in the Lower Devonian, followed by the numerous true bony fish in the Middle Devonian. (d) Devonian fishes possessed jaws, for the most part, in contrast with the suctional mouths of the Silurian types.

It appears obvious that with increased size, increased speed and a partial migration to marine waters where eurypterids were absent, the vertebrates of the Devonian ceased in great measure to be a possible source of food supply for the eurypterids. Further, with the development of predacious habits and increased size in vertebrates, the tables might have been turned, and the eaters become the eaten. It would reasonably follow (1) that eurypterids would decline in numbers and (2) that armor, now no longer needed, would tend to disappear from the vertebrates.

It is possible that this early eurypterid "menace" may have been influential in vertebrate evolution in other respects than that of skeletal development. It seems not improbable that much of the locomotor activity which is so characteristic of vertebrates as a group may have developed in relation to escape from eurypterids. If we assume an early evolutionary stage in which vertebrates together with eurypterids inhabited the estuaries and the sluggish waters of lowland regions, it is obvious that a premium is placed on active movement. First, it would be an immediate aid in escaping from eurypterid attack. But of seemingly greater significance is the fact that increased mobility would allow of migration to the higher reaches of river systems, in whose swifter waters the eurypterids, with a radically different type of locomotor equipment, would find life much more difficult.

Again, this suggestion of development of more mobile types in higher land regions suggests an explanation for certain puzzling lacunae in our knowledge of early vertebrate history. I shall cite but one example.

The higher bony fish groups, the *Osteichthyes,* are the dominant fresh-water types from Middle Devonian times on. In the Middle Devonian they are very abundant, and already highly diversified; obviously they had already passed through a long evolutionary history which must have begun in Silurian days. But their appearance on the paleontological stage is a dramatically sudden one. In contrast to their abundance in the Middle Old Red Sandstone, almost no traces of bony fishes are found in Lower Devonian deposits and it has been assumed that the early evolution of these active and generally predaceous forms might have been undergone in some unknown continental area.

But it must be noted that, in general, fossiliferous deposits are not laid down in the higher courses of rivers, but only in lowland regions, in areas of lakes and slowly moving streams. It is highly probable that the early development of the *Osteichthyes* took place not necessarily in unknown regions of the earth but rather in highland areas for which no depositional record is preserved. In such an environment the sluggish, bottom dwelling mode of life of their ancestors would of necessity have been transformed into the active habits characteristic of bony fishes. Concomitantly may have occurred the evolution of jaws, permitting the development of a carnivorous mode of life in contrast to the mud-grubbing which alone was possible in the sedentary jawless ancestors. These changes accomplished, the bony fishes, now fit to

[4] C. Schuchert, in *Proc. Nat. Acad. Sci.,* Vol. 2, 1916, p. 731.

maintain themselves against the eurypterids, might return to the lowlands—and thus appear at last in the fossil record.

I would by no means claim that all the facts of eurypterid and early vertebrate history are to be explained as due to the interrelations of these two groups. It is probable that the eurypterids had other sources of food than that supplied by the vertebrates, and many other factors may have influenced their decline and fall. Nor do I believe that the early steps in vertebrate evolution are to be explained entirely and simply as related to a defense against eurypterids. But it is impossible to believe that these two groups could have existed in close contact for many millions of years without a considerable influence upon each other. And it is highly probable that many facts regarding the motility, habitat and particularly the skeletal development of the early vertebrates are intimately related to the necessity of escape from eurypterid enemies.

SCIENTIFIC EVENTS

THE BUCKSTON BROWNE SURGICAL RESEARCH FARM

ACCORDING to the report in the London *Times*, the new Buckston Browne Surgical Research Farm at Down, near Farnborough, was opened on July 12 by Sir Holburt Waring, president of the Royal College of Surgeons of England. The establishment has been endowed and given to the college, at a total cost of £100,000, by Sir Buckston Browne, R.C.S. It comprises a residential hostel for surgical and biological workers, a separate building containing laboratories and accessory rooms, and 13 acres of grounds.

The estate adjoins that of Down House, where Charles Darwin lived and worked for 40 years and died in 1882. Down House represents another great benefaction of Sir Buckston Browne, by whom, as a tablet there records, it was "acquired, restored, endowed and presented to the British Association as trustee for the nation" five years ago. Sir Buckston Browne attended the opening. Among others present were Sir Arthur Keith, the director of the establishment, Lord and Lady Moynihan, Sir John and Lady Bland-Sutton, Sir Charles Sherrington, Professor E. L. Kennaway, Professor G. Grey Turner and Mr. O. J. R. Howarth, secretary of the British Association.

Sir Holburt Waring described the research farm as a magnificent donation in the interests of the advancement of surgery by one of their own profession, and observed that it was to the association of the surgeon with the biologist that they looked for the great advances of surgery in the future. He said that during recent decades surgery had made most of its advances through improved technique and the application of Listerian principles. More recently, however, radiological methods (x-ray and radium), together with biochemical and biophysical processes, had played an increasing and very important rôle in the diagnosis and treatment of disease, and in the understanding of the associated biological factors. They hoped to solve there by experimental methods many of the fundamental problems which beset surgery to-day. It was possible that many might be solved; others would prove exceedingly difficult.

Sir Buckston Browne said that they were assembled upon a remarkable spot. On the other side of the hedge had lived and worked Charles Darwin, the great emancipator of the human mind; this afternoon they had the privilege and joy of bringing here the genius of John Hunter, one of the great emancipators of the human body. One of Hunter's pupils was Edward Jenner, who worked at the prevention and mitigation of smallpox. The world quickly forgot its benefactors and their benefactions, and few even of those present realized the enormous debt they owed to Jenner. Many of them would have been dead long ago had it not been for Edward Jenner; many would have been sitting there with horrible scars. The world nearly lost Lord Lister from smallpox.

He would like to say one word about those who opposed all experimentation on animals. He maintained that the whole of the animal kingdom was as precious to the medical profession as to any other collection of men. Their whole lives were spent in the alleviation of pain and the prolongation of life; and nearly all that was done for man—who was only the head of the animal kingdom—was now done in our veterinary colleges and hospitals.

Sir Arthur Keith thanked the donor of the farm for "the most generous benefaction and the best aid to medicine that has been made in my time."

THE DUTCH ELM DISEASE IN NEW JERSEY

THE Dutch elm disease has broken out anew in the United States. This time it has been found in the state of New Jersey. Sixty-nine infected trees have been found scattered among the elms of an area of perhaps a hundred and fifty square miles in Essex, Hudson and Passaic counties, according to a statement given out by R. Kent Beattie, of the Bureau of Plant Industry, who has returned to Washington after investigating the outbreak in New Jersey. The

Public Works Administration, acting under the National Industrial Recovery Act, has authorized the Department of Agriculture to spend up to $80,000 to combat the disease.

This new epidemic infection is in the vicinity of our largest seaport and is in an area where the elm is one of the most important trees. It is also feared that the disease may be present in other localities from which it has not yet been reported.

"Watch for wilting or yellow or brown leaves accompanied by brown streaks in the young wood," Mr. Beattie advises. "When such cases are found, cut pieces of the infected twigs as big as a lead pencil and send them to the Dutch Elm Disease Laboratory, care Experiment Station, Wooster, Ohio. If you are in the infected region or its vicinity send your specimens to, or communicate with, the Dutch Elm Disease Office, care Shade Tree Commission, City Hall, East Orange, N. J., telephone No. Orange 3–4100. There are other diseases with the same symptoms and we can not be sure of the cause of the trouble till the specimens have been cultured."

The Cleveland, Ohio, infection of this disease is said to be well in hand. Three trees were found in 1930, four in 1931, none in 1932 and one tree thus far this year. Only one tree was ever found in Cincinnati and that in 1930. These are the only infections found on this continent till the outbreak in New Jersey.

All the New Jersey state and local authorities are cooperating with the federal department to find and eradicate this disease before it spreads further. A force of men is already at work in the region.

According to information given to the *United States Daily* by Mr. Beattie, it is not known how the disease was brought to this country. It was at first thought that it might have been brought in by importations of European nursery stock, but all importations have been investigated and it has been found that was not the source of the infection. No conclusions have been reached in investigations which have been conducted to discover how the disease is spread. It is thought possible that the European elm-bark beetle may be a factor.

The Dutch elm disease is comparatively new in Europe. It was first discovered in The Netherlands in 1919. Since that time it has spread to most of Europe, creating havoc with European elms. It has been found that the American elm is particularly susceptible to injury.

Experiments conducted by government officials show that all the major species of elms in this country are susceptible. Besides the elms it also affects the Japanese keyaki tree. Chinese elms have been found to be resistant to the infection.

In emphasizing the danger of the disease spreading over the entire country, Mr. Beattie cited the history of the chestnut blight. This disease, discovered in New York City in 1904, has killed practically all the chestnuts in the northeastern part of the United States and has spread to the northernmost limits of chestnut growth. It is now killing chestnut trees in the southern states. The Dutch elm disease kills an infected tree in one to two years.

The U. S. Department of Agriculture Circular 170-C, entitled "The Dutch Elm Disease," gives detailed information in regard to the disease.

THE RAINBOW BRIDGE-MONUMENT VALLEY EXPEDITION

A RECONNAISSANCE, designed to contribute to the correlation and extension of work already done by Jackson, Gregory, the Wetherills, Guernsey, Bernheimer, Cummings, Myser, Gladwin and others, is now being made in the northern Navajo country, just south of the San Juan and Colorado Rivers, by what is believed to be the largest and in some respects the best equipped scientific party thus far sent into the southwestern United States. It calls itself the Rainbow Bridge-Monument Valley Expedition, and is under the promotion and general direction of Ansel F. Hall, chief forester of the National Park Service, which, without subvention, gives the enterprise sponsorship. The expedition will submit a report to the secretary of the Department of the Interior, through the director of the National Park Service. Besides a number of supporting amateur scientists from universities and school faculties, with packers and camp assistants of the same quality, the expert personnel comprises Lyndon L. Hargrave, assistant director and archeologist of the Museum of Northern Arizona at Flagstaff; Alonzo W. Pond, archeologist to the most recent Andrews expedition into Mongolia, and Benj. Wetherill, of Kayenta, Arizona; Thorn L. Mayes, engineer, General Electric Company, Oakland, California; Dr. C. M. Wheeler, department of entomology; Dr. T. H. Eaton, for the Museum of Vertebrate Zoology, and V. L. VanderHoof, curator of the Museum of Paleontology, all of the University of California, and Robert Kissack, cinematographer, department of visual education, University of Minnesota. Among assistant leaders, collectors, etc., are Elbert Smith and Robert Thomas, mapping, University of California; Marvin Darsie and Morgan Boyers, botany and zoology, University of California; Edward Harrington, geology, University of Pittsburgh; Charles R. Brady, geology, Pratt Institute; Charles Harkness, University of California, and J. C. Fisher Motz, Carnegie Institute, architects, archeological draughting, W. L. Lowrey, University of California, and Winters High School, geology, and Jesse Peter,

curator of the Santa Rosa Junior College Museum, general collecting. T. R. Kelley, University of California, is field director, assisted by John Armstrong, University of California School of Forestry. The western members arrived at Kayenta, remotest post office in the United States, on June 11, and their eastern associates arrived on July 2, the entire body dividing into three self-contained camps—geological and topographical, biological, archeological—working at times eighty miles from one another. For a week in mid-June, the party had invaluable assistance from Frank L. Naylor, of Berkeley, and the use of his private plane. Not only were many illuminating still and motion pictures taken from Mr. Naylor's plane; it also enabled the picking up of ground features not recognizable by a man on the surface. The western group had, in the main, left the field by August 2, the easterners will leave about three weeks later. From the spectacular and scenic point of view, the climax of the expedition will be a three-weeks exploration, by means of seven specially equipped boats, of the lower San Juan River and thence of the Colorado as far as Lee's Ferry. A special object of this voyage is a complete pictorial record, including motion pictures. It is hoped that the expedition will have a pictorial record much surpassing anything heretofore obtained in the region occupied.

THE WHITE MOUNTAINS MEETING OF THE AMERICAN FORESTRY ASSOCIATION

THREE days of motor trips through the White Mountains of New Hampshire will be a feature of the fifty-eighth annual meeting of The American Forestry Association early in September. The dates of the meeting are September 5, 6, 7 and 8. Interspersing the field trips will be evening and midday gatherings at which Secretary of Agriculture Henry A. Wallace, Governor John G. Winant, of New Hampshire, Senator David I. Walsh, of Massachusetts, Robert Fechner, director of the Civilian Conservation Corps, Henry S. Graves, dean of the Yale Forest School, R. Y. Stuart, chief forester of the United States, and others will speak.

Seven other conservation organizations are participating: The Society for the Protection of New Hampshire Forests, the Massachusetts Forest and Park Association, the Appalachian Mountain Club, the Connecticut Forest and Park Association, the New England Section of the Society of American Foresters, the Empire State Forest Products Association and the Rhode Island Forestry Association. Attendance, however, is not limited to association members. All sessions, trips and privileges of the meeting are open to the public and the public is cordially invited to attend.

The headquarters will be the Forest Hills Hotel at Franconia, New Hampshire, from which point a caravan of motor cars will leave each morning on trips especially planned to demonstrate the more important conservation work of the White Mountain National Forest and the surrounding region. Included in the trips are visits to the more important projects of the Forest Service, the state of New Hampshire, the Society for the Protection of New Hampshire Forests and the Appalachian Mountain Club—organizations which have been working in cooperation for many years in the conservation and development of the region as a whole. The field trips have been planned so as to give within the time available the best possible picture of achievements in watershed protection, preservation of esthetic values, forest management, the handling of public recreation, roadside and trail treatment and other public developments.

The field trips will be without cost except for a moderate charge for lunches. Notable among the field events will be a visit to the Emergency Conservation Camp at Wildwood in the White Mountains National Forest, where visitors may see first hand how the Civilian Conservation Camps are conducted, the types of young men enrolled and the character of work being done. President Franklin D. Roosevelt has been invited to be the principal guest of honor, and in the event affairs permit him to accept, a special presidential luncheon will be given in his honor at the Mt. Washington Hotel, Bretton Woods, on Friday, September 8. Following the adjournment of the meeting with the Mt. Washington luncheon a number of special trips will be arranged if there is demand for them, including a visit to the operations of the Brown Company at Berlin, New Hampshire, where special arrangements will be made to show visitors the interesting and diversified developments of that company in the harvesting and utilization of forest products, and a trip to the top of Mt. Washington by the Cog Railroad, for which a special rate of $5 has been obtained, including dinner on the summit at the Mt. Washington Club. Those desiring to spend the night on the summit will be granted the special rate of $6 per person, including the ride up the mountain.

Dinner at the Forest Hills Hotel at Franconia, New Hampshire, on the evening of September 5, will open the meeting. The hotel has granted special rates of $5 a day for room and meals and is equipped to care for 150 people. This rate applies to rooms with bath as far as available. Those desiring to come before the convention or remain afterwards will be allowed the special convention rates. In Franconia Village and vicinity are numerous summer hotels where clean and comfortable accommodations may be obtained at $3 a day and up. Further information in regard to hotels, rates and other details may be obtained by

writing to The American orestry Association, 1713 K Street, N.W., Washington, D. C. Room reservations will be made by the association, or they can be obtained by writing directly to the Forest Hills Hotel, Franconia, New Hampshire.

OBITUARY

DR. FRANK R. VAN HORN, professor of geology and mineralogy in the Case School of Applied Science, Cleveland, councilor of the Geological Society of America and secretary of the Mineralogical Society of America, died on August 1 at the age of sixty-one years.

JOHN R. DYER, executive dean and professor of psychology at the southern branch of the University of Idaho, was killed in an automobile accident on August 5. He was forty-four years old.

DR. ROBERT EMERSON WALL, assistant professor of entomology at the Montana Agricultural Experiment Station, died on July 29 in his thirtieth year.

BERT RUSSELL, associate examiner at the Patent Office in charge of chemical cases, died by suicide on July 31.

CLIVE E. LORD, director of the Tasmanian Museum and Art Gallery, known for his work on the natural history of Tasmania, has died at the age of forty-three years.

THE death at the age of sixty-two years is announced of Professor Dr. Georges Joannovic, dean of the Faculty of Medicine in Belgrade, of which he was the founder.

SCIENTIFIC NOTES AND NEWS

PRESIDENT ROOSEVELT has issued the following executive order: "The National Research Council was created at the request of President Wilson in 1916 and perpetuated by Executive Order No. 2859, signed by President Wilson on May 11, 1918. In order to carry out to the fullest extent the intent of the above Executive Order, there is hereby created a Science Advisory Board with authority, acting through the machinery and under the jurisdiction of the National Academy of Sciences and the National Research Council, to appoint committees to deal with specific problems in the various departments. The Science Advisory Board of the National Research Council will consist of the following members who are hereby appointed for a period of two years: Karl T. Compton, *chairman,* president, Massachusetts Institute of Technology; W. W. Campbell, president, National Academy of Sciences, Washington, D. C.; Isaiah Bowman, chairman, National Research Council, and director, American Geographical Society, New York City; Gano Dunn, president, J. G. White Engineering Corporation, New York City; Frank B. Jewett, vice-president, American Telephone and Telegraph Company, and president, Bell Telephone Laboratories; Charles F. Kettering, vice-president, General Motors Corporation, and president, General Motors Research Corporation, Detroit; C. K. Leith, professor of geology, University of Wisconsin; John C. Merriam, president, Carnegie Institution of Washington; R. A. Millikan, director, Norman Bridge Laboratory of Physics, and chairman of the Executive Council, California Institute of Technology."

PROFESSOR GEORGE R. MINOT, of the Harvard Medical School and director of the Thorndike Memorial Laboratory in the Boston City Hospital, discoverer in 1926 of the liver treatment for pernicious anemia, has been awarded the Moxon Gold Medal of the Royal College of Physicians, London.

DR. ARTHUR H. COMPTON, professor of physics in the University of Chicago, has been elected president of the alumni of Wooster College.

DR. A. ROBERTSON, of the London School of Hygiene and Tropical Medicine, has been appointed to the Heath Harrison chair of organic chemistry at the University of Liverpool, in succession to Professor I. M. Heilbron, who resigned recently.

DR. RALPH M. F. PICKEN, medical officer of health of the City of Cardiff, Wales, has been appointed Mansel Talbot professor of preventive medicine in the Welsh National School of Medicine, Cardiff, in succession to Professor E. L. Collis, who is retiring.

DR. H. JONES has been appointed lecturer in theoretical physics at the University of Bristol.

THE title of professor of medical entomology has been conferred on Dr. P. A. Buxton, of the London School of Hygiene and Tropical Medicine, and that of professor of pharmacology on Dr. J. H. Burn, director of the pharmacological laboratory of the Pharmaceutical Society, by the University of London.

THE Medical Research Council has appointed Professor Edward Mellanby secretary in succession to the late Sir Walter Morley Fletcher. Dr. Mellanby, who has been professor of pharmacology in the University of Sheffield since 1920, is at present a member of the council. He will not assume full duty as secretary until next January. The secretary of the Medical Research Council is *ex officio* secretary of the Committee of Privy Council for Medical Research.

Nature reports that Dr. W. L. Balls, director of the Botanical Section, Ministry of Agriculture, Egypt,

has been appointed cotton technologist to the Ministry of Agriculture, Egypt. Dr. J. Templeton has been appointed director of the Botanical Section in succession to Dr. Balls. Dr. Templeton has been in the service of the Egyptian Government since 1921, prior to which he was a lecturer in the Botanical Department of the University of Edinburgh. A. Jones has been appointed to be assistant superintendent of agriculture, Gold Coast.

THE Linnean Society of London has elected foreign members as follows: Dr. Elmer D. Merrill, director of the New York Botanical Garden; Dr. Erwin Baur, director of the Kaiser-Wilhelm Institute of Genetics, Müncheberg; Dr. Adolf Pascher, professor of botany in the German University, Prague, and Dr. Filippo Silvestri, professor of genetics and agrarian zoology, Portici.

DR. EGAS MONIZ, of Lisbon, and Dr. De Beco, of Liège, have been elected foreign corresponding members of the Paris Academy of Medicine.

THE degree of doctor of science was recently conferred in biochemistry by the University of London on A. G. Norman, Rothamsted Experimental Station, for a published work entitled "The Biological Decomposition of Plant Materials," and in biology on Dr. R. Ruggles Gates, professor of botany at King's College, for published works on mutation, heredity, eugenics and evolution.

THE College of Physicians of Philadelphia announces that the Alvarenga Prize, amounting to about $300, has been awarded to Drs. Harry Shay and Jacob Gershon-Cohen, Philadelphia, for their essay entitled "Experimental Studies in Gastric Physiology in Man." The prize essay may be on any subject in medicine and must represent an addition to the knowledge and understanding of the subject, based on either original or literary research. It was not awarded in 1932.

DR. WERNER E. BACHMANN, assistant professor of organic chemistry at the University of Michigan, was recently named the recipient of the Henry Russel award, made annually to a member of the faculty in recognition of scholarly achievement and promise.

DR. WALTER B. CANNON, George Higginson professor of physiology at the Harvard Medical School, has been elected a trustee of Radcliffe College, for a three-year term.

DR. ROBERT MARSHALL, collaborator of the U. S. Forest Service, has been appointed director of forestry in the Indian Service.

DR. GEORGE H. BIGELOW, Massachusetts State Commissioner of Public Health since 1925, has resigned to become director of the Massachusetts General Hospital. Dr. Henry D. Chadwick, of Westfield and Detroit, has been appointed health commissioner.

DR. L. A. RAMADA has been placed in charge of a section of agricultural meteorology of the Meteorological Department of India, which was established, according to *The Experiment Station Record,* for a period of three years at Poona, financed by the Imperial Council of Agricultural Research.

THE Committee on Scientific Research of the American Medical Association has made a grant to Dr. and Mrs. Frederic Gibbs to provide for the completion of their study of the convulsion threshold of various parts of the cat's brain. The committee has also made an additional grant to Dr. C. C. Speidel, professor of anatomy in the University of Virginia Medical School, in support of his studies of living nerves.

DR. RICHARD C. TOLMAN, professor of physical chemistry at the California Institute of Technology, sailed for Europe on August 2.

DR. WILLIAM BEEBE, director of the department of tropical research of the New York Zoological Society, has returned from a trip to the Gulf of Panama.

A SPECIAL cable from Moscow to *The New York Times* reports that Dr. Roy Chapman Andrews, of the American Museum of Natural History, is in Moscow to discuss plans for a geological exploration trip to Soviet Central Asia which he hopes to make next year jointly with the Leningrad Academy of Science.

AN Associated Press dispatch reports that a hill at Newport, Isle of Wight, has been named for Dr. Fridtjof Nansen, the Norwegian explorer and diplomat, and presented to the British nation by Dr. Howard Whitehouse, warden of a school. Nansen Hill commands a fine view of the English Channel.

GEORGE CLINTON SWALLOW, first professor of geology, chemistry and agriculture and first dean of the College of Agriculture at the University of Missouri, was honored during commencement activities, when a bronze tablet at the entrance to Swallow Hall was unveiled. Speakers included Dean F. B. Mumford, of the College of Agriculture; Dr. Benjamin F. Hoffman, emeritus professor of Germanic languages, who was one of Dr. Swallow's students; Wilford Cline, Atlanta, representing the Geological Club of the university, and E. A. Trowbridge, Jr., representing the Agricultural Club. Dr. Edwin B. Branson, professor of geology, was in charge of program arrangements. The tablet bears the following inscription: "George Clinton Swallow, A.M., M.D., LL.D., 1817–1899. First

professor of geology, chemistry, agriculture, and first dean of the College of Agriculture, University of Missouri. First State Geologist of Missouri. Erected by Boone County Historical Society, Agricultural Club and Geological Club." Dr. Swallow began his career in the university on January, 1852. He resigned in 1853 to become state geologist, but returned to the university in 1870, remaining until 1882.

The British Medical Journal reports that the German Physiological Congress, which was to have been held this year at Innsbruck, has been indefinitely postponed. The following German congresses will be held in September: Society for Thalassotherapy at Norderney in the first week of September; twenty-second congress of the Society for Forensic and Social Medicine at Munich, September 4 to 7; Society for Study of Heredity at Göttingen, September 6 to 9; Society of History of Medicine at Erfurt, September 9 and 10; Orthopaedic Society at Leipzig, September 11 to 13; Society for Microbiology at Munich, September 21 to 23.

ABOUT 1,000 men in many states will be returned to work by the Department of Commerce as a result of the allocation of $2,600,000 by the Public Works Administration to the Coast and Geodetic Survey, according to an announcement made by Secretary Roper. Secretary Roper stated that the money will be expended within the next twelve months for the purpose of conducting surveying work throughout the country and along the Atlantic, Gulf and Pacific coasts. About 70 per cent. of the fund will be paid out directly as wages to men urgently in need of work, and the remainder will be spent chiefly for the operation of surveying parties. The work, while technical in character, is of such importance that, in spite of the recent depression, three states—North Carolina, California and New Jersey—have voluntarily contributed state funds in order that the work within their boundaries might be completed more promptly under the direction of the survey than would otherwise be possible.

Nature reports that the British Genetical Society is raising a fund for the benefit of genetical workers, regardless of nationality, who have lost their positions as a result of racial or political discrimination, to be administered by the society's committee, in cooperation with relief organizations. Grants will be made to as many individuals as the sum subscribed will warrant, in order to assist them to carry on research work in the British Empire.

A GRANT of $58,500 has been made to the Washington University School of Medicine from the Rockefeller Foundation towards the expense of conducting a five-year research project in the physiology of the nervous system. This grant will provide for the expansion of a comprehensive program of research on the nervous system, which has been under way in the School of Medicine for a number of years and in which several of the departments of the school have cooperated. The work to be done under the present grant will be conducted chiefly by Dr. George H. Bishop, professor of biophysics in the Washington University School of Medicine, and by Dr. S. Howard Bartley, research associate of biophysics and psychology. The work, which will be done in the laboratories of the Oscar Johnson Institute for Research, is based on the fundamental series of investigations on the nature of nervous activity carried out by Dr. Joseph Erlanger and Dr. Herbert S. Gasser, now of the Cornell University Medical College, and their associates in the department of physiology.

WITH a total number of 1,471,016 visitors checked through its doors from January 1 to July 23, inclusive, the Field Museum, Chicago, has had a gain in attendance of 585,057 persons thus far in 1933, or more than 66 per cent. as compared with 1932, when up to the same date the total attendance was 885,959. While a certain amount of this increase may be attributed to the museum's proximity to the grounds of A Century of Progress Exposition, there is said to be a large normal increase. The attendance from January 1 to May 26, 1933, inclusive (the period prior to the opening of the exposition), was 707,245, which compares with the 549,407 registered between the same two dates of 1932. Thus the pre-exposition period of 1933 shows an increase of 157,838, or more than 28 per cent. over 1932.

DISCUSSION

THE SCIENTIFIC WORK OF THE GOVERNMENT

AN appeal to the President on behalf of the scientific work of the government, recently much curtailed by cuts in appropriations, has been circulated in New York for signatures. It reads:

The undersigned hereby protests against the recent wholesale reductions, amounting to more than ten million dollars, in the Government appropriations for the Bureau of Standards, the Public Health Service, the Geological Survey, the Bureau of Mines, the Bureau of Fisheries, the various State agricultural experiment stations, and many other testing and research activities.

These reductions will result or have already resulted in the temporary or permanent dismissal of many hundreds of trained, able, and efficient scientists. They mean that many research projects of great importance for the

efficient operation of these branches of the Government will be abandoned, while valuable apparatus and equipment will lie idle. Unemployment will be increased at the very time when other branches of the Government are incurring large expenses in the effort to put men back to work.

Moreover, the savings which can result from these reductions are only a few millions, while at the same time the Government is making new appropriations of hundreds of millions of dollars for other purposes.

The undersigned believes that to neglect scientific research and to discharge highly trained research workers is a step backward and will prove very costly to the Government, and therefore most respectfully appeals to you to restore the appropriations for the scientific work of the Government.

For detailed information as to the situation in the Government Scientific Bureaus see *Science News Letter*, July 8, p. 31; July 15, pp. 35–39; July 22, pp. 51, 61; July 29, pp. 77–78; SCIENCE, July 21, pp. 53, 61; July 28, p. 86. The undersigned urge readers of SCIENCE to send to President Roosevelt the above or a similar appeal.

GEORGE B. PEGRAM
ARTHUR H. COMPTON
BERGEN DAVIS
DAVID SINCLAIR
WILLIAM F. BROWN

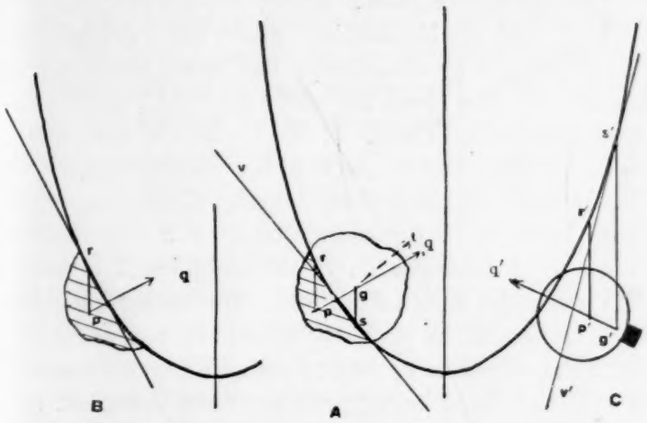
DEPARTMENT OF PHYSICS
COLUMBIA UNIVERSITY

THE RESULTANT FORCE ACTING ON A SOLID BODY FLOATING IN A BOWL OF ROTATING LIQUID

THE phenomenon here noted does not appear to have been recorded in any of our books of reference.

Since all points in the surface of a fluid in steady rotation about a vertical axis are on the same equipotential, the normal to the surface at any point gives the "apparent vertical" and the tangent, the "apparent horizontal" for that point. Further, due to the fact that the acceleration of each particle in the fluid has no vertical component, equipotential surfaces in the body of the fluid are paraboloids of the same dimensions as that formed by the free surface, and they have the same axis. All the particles in a given line parallel to the axis of rotation are in one and the same condition as regards velocity, acceleration, etc., and thus will have a common direction for their "apparent vertical," and their "apparent horizontals" will all be parallel to the plane tangent to the free surface at the point where the line in question cuts that surface.

Let the figure at *a* represent a solid (say a ping-pong ball) floating on the surface of a steadily rotating fluid. The hatched part represents the volume formerly occupied by the displaced fluid. To get the direction and line of action of the resultant of all the forces exerted on the solid by the fluid, consider the solid removed and the hatched portion again occupied by fluid, as in *b*. Next suppose that this portion of fluid acts as a solid, losing all mobility of one part relatively to another, but retaining its shape and density. Let the center of mass of this solid be at *p*. Then as the resultant force ($m\ r\ \omega^2$) and the weight ($m\ g$) of the portion both act through the center of mass, the necessary condition for steady rotation is



that the resultant of the forces due to the fluid external to this solid also act through *p*, and that it lie along the "apparent vertical" for the point *p*, *i.e.*, along *p q* parallel to the normal to the surface at *r*, *p r* being parallel to the axis of rotation.

Return now to the floating body at *a*. This, when in a steady state, will move with its center of mass *g* on the line *p q* (otherwise it would rotate in the plane of the diagram). Here we meet two cases with different results. First, bodies with their center of mass on *p q* but nearer the axis than *p*, and those which float with the center of mass farther from the axis than the center of mass of the fluid they displace, as shown at *c*. In the first case, as has been shown, the force due to the fluid pressures acts along *p q*, which is normal to the tangent plane at *r*, while the "apparent vertical" for the body (its center of mass) is *g t* normal to the tangent plane at *s*. Thus there is a component of the force *p q* along the "apparent horizontal" for the body, *v s*, and it moves towards the axis of rotation to reach equilibrium only at the vertex of the paraboloid, where its center of mass is on the axis of rotation of the fluid. On the other hand, consider a wooden ball loaded with lead so that it will just float (as shown at *c*, center of mass at *g'*). The same argument shows that the resultant force due to the fluid pressure is along *q' p'* (normal to the tangent plane at *r'*, but that the "apparent horizontal" for the system is parallel to the tangent plane at *s'*. So there is a component along that plane *v' s'* away from the axis, and the body moves "down hill" to a

position as far from the axis as possible. In each case the action is due to the difference in direction of the "apparent vertical" for the center of mass of the floating body, and that for the center of mass of the displaced fluid.

The phenomenon is easily observed by placing a crystallizing dish on the turntable of a victrola, fastening it centrally, half filling it with water, and after steady rotation has been established using the ping-pong ball and the weighted wooden ball as described above.

The experience recalls Edgar Allan Poe's tale "A Descent into the Maelstrom," where the old fisherman saved himself by abandoning the faster moving ship (center of mass above the water surface) for the cask that barely floated him. If Poe's tale were not merely a wild dream, one would look for the explanation of the motions of the floating objects, not in the reference he gives to the second book of a hypothetical work by Archimedes on *Hydrodynamics* (!)[1] but in the principles herein described. The vortex imagined by Poe would be probably more like a free vortex with the curvature convex to the axis, in which case it would have been better perhaps if the fisherman had stuck by his ship.

WILL C. BAKER

QUEEN'S UNIVERSITY,
KINGSTON, ONT.,
CANADA

SELENIUM AS AN INSECTICIDE

A RENEWED interest in the use of selenium compounds as insecticides prompts this communication, which may serve as a warning against such use without adequate investigation as to the possible dangers involved. In the search for better insecticides attention has been directed from time to time to the fact that selenium compounds possess many desirable qualities for this purpose. A number of patents have been granted in this country and abroad covering the use of selenium compounds for making insecticides. Although the use of such compounds may be very limited, it is believed that the danger of even minute quantities of selenium in soils on which food products are grown has not been fully appreciated.

Studies carried out during the past year in the Bureau of Chemistry and Soils and the Bureau of Plant Industry of the Department of Agriculture show that selenium in the soil is assimilated by plants and that a particularly toxic compound is elaborated. Fifteen parts per million of selenium in the soil, added as sodium selenate, and under some conditions even lower concentrations, produce distinct chlorosis and stunting of wheat plants. Quantities as small as one part per million permit growth and maturation with no visible symptoms of injury to the plant. However, when the grain or straw from such plants is fed to experimental animals, such as rats and guinea-pigs, it produces a pronounced toxicosis characterized by retardation in growth, and death occurs in a few weeks. Wheat which has been found by analysis to contain 8 to 10 parts per million of selenium, absorbed from the soil, produces fatal injury with, in many cases, readily detectable macroscopic changes in the liver. Selenium is present in the grain in intimate association with the protein, but in what form has not yet been determined.

In the case of common insecticides used in spraying fruit trees and vegetables, complete removal of the spray residue from edible food products, where this is possible, should eliminate the danger of the food being toxic. However, selenium can be assimilated from the soil by at least some and possibly all plants, and the degree of toxicity of the particular compound used in spraying a plant is not a measure of the toxicity of the compounds formed in the plant. Furthermore, there is evidence that selenium compounds may be reduced by soil organisms, so that spray residues ordinarily considered innocuous may be made available to the plant and be converted into highly toxic combinations.

E. M. NELSON
A. M. HURD-KARRER
W. O. ROBINSON

U. S. DEPARTMENT OF AGRICULTURE

THE CHROMOSOMES OF XIPHOPHORUS, PLATYPOECILUS AND THEIR HYBRIDS DURING MATURATION STAGES

IT has been known for several years that two genera of poeciliid top minnows, *Xiphophorus* and *Platypoecilus*, will readily hybridize and produce some fertile offspring.

An investigation of the chromosomes during the maturation stages of two species of *Xiphophorus*, *Platypoecilus couchiana* and *Platypoecilus maculatus* and of *Platypoecilus-Xiphophorus* hybrids has just been completed, and the detailed results of the investigation will appear in print in several months. Part of the material studied was collected in the field in Mexico and part was obtained from dealers.

The haploid number of chromosomes is twenty-four in *Xiphophorus*, *Platypoecilus* and in the hybrid. The chromosome picture is so nearly identical in all three that it is difficult to find any distinctive differences. In the primary spermatocyte division the heterotypic chromosomes are seen as nineteen spherical chromosomes of about equal size and five slightly larger ones, one of which is the sex chromosome.

[1] I take Poe's spelling *incidentibus* not for a misprint for *insidentibus* but as deliberate, and as a joke that he is trying to pull on the reader.

These larger chromosomes are always found at the periphery of the spindle.

The sex chromosomes are hardly distinguishable from the autosomes in the gonial divisions. In the primary spermatocyte division one of the larger chromosomes appears at the side of the spindle. In the prophase it is very slow in taking its place on the spindle and is often prematurely divided by the time it reaches its position on the equatorial plate. The daughter chromosomes of the prematurely divided sex chromosomes then precede all the autosomes, reaching the pole of the spindle long before the autosomes. Since each resulting secondary spermatocyte receives one of the two daughter chromosomes, which are identical, the condition is interpreted as one in which the male is homogametic. It would be inferred that the female would be heterogametic and the sex chromosomes would therefore represent the ZZ"–WZ type.

An unusual condition appears in the primary gonial division in *Xiphophorus* which is interpreted as a presynaptic pairing of the diploid chromosomes. A condition comparable to this may be present in *Platypoecilus,* but has not been seen in the hybrid.

E. M. RALSTON

NORTHWESTERN UNIVERSITY

INFLUENCE OF GREGARINES ON GROWTH IN THE MEALWORM

SOME *Tenebrio molitor* eggs were placed with sterilized food in a Petri dish. It was noted that larvae hatched away from adults did not develop as rapidly as did those hatching from eggs remaining in the culture with adults. It appears that the young may derive the gregarines either directly from the adults or from food in which the adults have remained for some time. Larvae reared with adults are larger and the mortality rate is less than those reared in sterile food in the absence of adults. Computation shows that 241 days after the beginning of the experiment the larvae reared without adults were on the average 6 mm shorter than larvae reared with adults.

It is known that the intestinal tract of Tenebrio larvae contains the protozoon, Gregarina. It was found that no larva from cultures lacking adults contained a gregarine and that no larva examined from the cultures containing adults lacked gregarines. Apparently these gregarines are essential for growth. It has not been learned whether the parasites have a function in digestive processes or not. This study is being continued.

RUTH SUMNER

UNIVERSITY OF COLORADO

SOCIETIES AND MEETINGS

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE thirty-second annual meeting of the North Carolina Academy of Science was held at Davidson College, Davidson, N. C., on May 5 and 6. Papers were presented before the general section of the academy on Friday morning and afternoon. On Friday evening the retiring president, J. B. Bullitt, professor of pathology in the University of North Carolina, gave the presidential address on "Early Man, Some Comparisons, Not Odious." On Saturday morning the academy met in the following sections: general section, chemistry section, mathematics section and physics section. Sixty-nine papers and six exhibits were on the program. Abstracts of most of these papers and complete papers of several will appear at an early date in the *Journal of the Elisha Mitchell Scientific Society,* Vol. 49, No. 1.

Resolutions of respect were passed in honor of Dr. Clarence A. Shore, director of the State Laboratory of Hygiene at Raleigh, and for the Reverend George W. Lay, of Chapel Hill.

The executive committee reported the election of thirty new members during the year, and the reinstatement of five former members. One hundred and thirty-three registered at the meeting.

Lane Barksdale, of the Greensboro Senior High School, for his essay, "Orchid Hunting in Guilford County," was declared the winner of the High School Science Prize, a silver loving cup, for the best essay submitted by a high-school student. Essays for 1933 were confined to the fields of biology and geography.

The officers elected for the year 1934 were:

GENERAL ACADEMY

President, B. W. Wells, State College
Vice-president, Helen Barton, Woman's College
Secretary-treasurer (for three years), H. L. Blomquist, Duke University
Representative to the American Association (for two years), C. F. Korstian, Duke University

CHEMISTRY SECTION

Chairman, H. D. Crockford, University of North Carolina
Vice-chairman, J. E. Saylor, Duke University
Secretary-treasurer, R. W. Bost, University of North Carolina
Councilor, N. Isbell, Wake Forest College

MATHEMATICS SECTION

Chairman, E. L. Mackie, University of North Carolina
Secretary, E. R. C. Miles, Duke University

PHYSICS SECTION

Chairman, E. K. Plyler, University of North Carolina
Secretary, C. N. Warfield, Woman's College

The thirty-third annual meeting of the North Carolina Academy of Science will be held at the University of North Carolina, Chapel Hill, N. C., in the spring of 1934.

H. R. TOTTEN,
Secretary

THE INDIANA ACADEMY OF SCIENCE

THE Indiana Academy of Science met from May 25 to 27, 1933, at Clifty Falls State Park for its regular spring meeting. The formal address was given by Mr. Curtis Marshall, president of the Jefferson County Historical Society, on "Some Incidents in Local History." The primary purpose of the spring meeting is to study regions of particular geological, botanical or zoological interest, so that one whole day was spent in field trips to the Fourteen-mile Creek area, Rose Island, and to the Forestry Farm near Henryville.

The forty-eighth annual fall meeting of the academy was held at South Bend, from November 17 to 19, 1932, the academy being the guests of the University of Notre Dame. Dr. Fernandus Payne, Indiana University, was chairman of the meeting. A total of 116 papers on bacteriology, botany, chemistry, geology and geography, physics and mathematics and zoology were presented. The meeting closed with the annual dinner, held in the faculty dining room of the University of Notre Dame, at which the following officers were chosen for 1933: Marcus W. Lyon, Jr., South Bend, *president;* H. S. Markle, Earlham College, *vice-president;* Ray C. Friesner, Butler University, *secretary;* Paul Weatherwax, Indiana University, *treasurer;* Stanley A. Cain, Indiana University, *editor;* Will E. Edington, DePauw University, *press secretary.* The fall meeting for 1933 will be held from October 12 to 14, at Indiana University.

WILL E. EDINGTON,
Press Secretary

REPORTS

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

THE Committee on Grants-in-Aid of the National Research Council made seventy-four grants last spring for the support of individual research, as follows, from 249 applications received:

Kenneth T. Bainbridge, Bartol Research fellow, Bartol Research Foundation of the Franklin Institute, isotopes of light chemical elements; S. J. Barnett, professor of physics, University of California at Los Angeles, a gyrostatic method for the process of magnetization in strong fields; J. W. Beams, professor of physics, University of Virginia, magneto-optical method of chemical analysis of solutions; Samuel L. Boothroyd, professor of astronomy, Cornell University, the spectra of O, B and A type stars at the Lowell Observatory Mountain Station, Arizona; G. Breit, professor of physics, L. P. Granath, instructor in physics, and J. L. Rose, instructor in physics, New York University, measurement of hyperfine structure of spectral lines; Jesse W. M. DuMond, research associate in physics, California Institute of Technology, the construction of a high energy x-ray tube; S. A. Mitchell, director, Leander McCormick Observatory, University of Virginia, the spectra and photographic magnitudes of faint stars; Harald H. Nielsen, professor of physics, Ohio State University, the infrared region of the spectrum; Thomas C. Poulter, professor of physics, Iowa Wesleyan College, physical observations in connection with the second Byrd Antarctic Expedition; Francis G. Slack, associate professor of physics, Vanderbilt University, the magnetic rotation of the plane of polarization of light; J. C. Stearns, professor of physics and mathematics, University of Denver, distribution of the intensity of cosmic rays at high altitudes.

Corbin T. Eddy, associate professor of metallurgy, Michigan College of Mining and Technology, development of a thermo-analyzer; Richard H. Frazier, assistant professor of electrical engineering, Massachusetts Institute of Technology, Thompson effect in electric circuits; Kenneth G. Merriam, assistant professor of aeronautical engineering, Worcester Polytechnic Institute, air flow around standard pitot-static heads.

Francis E. Blacet, instructor in chemistry, University of California at Los Angeles, the effects of monochromatic ultra-violet radiation upon organic substances in the vapor phase; Charles B. Hurd, professor of chemistry, Union College, the process of setting of silicic acid gels; I. M. Kalthoff, professor of analytical chemistry, University of Minnesota, internal structural changes taking place in fresh precipitates of lead sulfate; Gilbert N. Lewis, professor of chemistry, University of California, the separation and properties of pure isotopes; James W. McBain, professor of chemistry, Stanford University, construction of an ultracentrifuge; William A. Noyes, Jr., associate professor of chemistry, Brown University, absorption spectra of organic compounds, particularly ketones; H. I. Schlesinger, professor of chemistry, University of Chicago, hybrides of boron.

Charles I. Alexander, assistant professor of geology, Texas Christian University, fossil Ostracoda of Texas; Ira S. Allison, professor of geology, Oregon State Agricultural College, Pleistocene history of the Willamette Valley, Oregon; Ralph L. Belknap, assistant professor of geology, University of Michigan, upper air conditions over the Greenland Ice Gap; Margaret Fuller Boose, Madison, Wisconsin, granites of the Front Range, Colo-

rado; Arthur Keith, U. S. Geological Survey, mountain building in New England and Quebec as evidenced by Ordovician and Silurian formations; Kenneth K. Landes, associate professor of geology, University of Kansas, study of the molybdenite-bearing pegmatite at Climax, Colorado; J. F. Lutz, assistant professor of soils, North Carolina State College, the physical and chemical properties of soils which affect soil erosion; Evans B. Mayo, instructor in petrography, Cornell University, the Sierra Nevada granites between Mono Lake and Round Valley, California; Elizabeth McCoy, assistant professor of agricultural bacteriology, University of Wisconsin, the rôle of microorganisms in the diagenesis of the sediments of a fresh-water lake; Raymond C. Moore, professor of geology, University of Kansas, stratigraphic and paleontologic studies of the Carboniferous rocks in Wyoming; Francis L. Parker, research assistant, Cushman Laboratory for Foraminiferal Research, the genus *Bulimina* and related genera; William F. Prouty, professor of geology, University of North Carolina, the Silurian system in the Southern Appalachian Mountains; C. Warren Thornthwaite, assistant professor of geography, University of Oklahoma, the climatic basis of forest distribution in eastern North America; Samuel Weidman, professor of geology, University of Oklahoma, dolomitization, silicification and related phases of mineralization associated with the zinc-lead ore deposits of the Tri-State district.

Joseph D. Aronson, assistant professor of bacteriology, Henry Phipps Institute, relation of tuberculosis and syphilis in experimental animals; Robert Chambers, professor of biology, New York University, secretionary function in tissue culture; Ernest C. Faust, professor of parasitology, Tulane University School of Medicine, *Schistosoma mansoni* infection in Puerto Rico; Robert Gesell, professor of physiology, University of Michigan, action potentials of the nerve cells and fibers constituting the respiratory center; Arthur Grollman, associate professor of pharmacology and experimental therapeutics, Johns Hopkins University Medical School, the active principle of the adrenal cortex; Sanford B. Hooker, professor of immunology, Boston University School of Medicine, quantitative studies of precipitin reactions; E. V. McCollum, professor of chemical hygiene, School of Hygiene and Public Health, Johns Hopkins University, supplementing fat-free diets with refined fat-soluble dietary essentials; F. A. McJunkin, professor of pathology, Loyola University School of Medicine, inhibition of the proliferation of kidney cells; Valy Menkin, instructor in pathology, Harvard University Medical School, inflammatory reaction in relation to immunity; Robert A. Moore, instructor in pathology, Western Reserve University, senile changes in the prostate gland; Torald Sollman, professor of pharmacology and materia medica, Western Reserve University School of Medicine, the excretion and distribution of bismuth during clinical treatment; Hans Zinsser, professor of bacteriology and immunology, Harvard University Medical School, protective and therapeutic value of vaccines and serums in the treatment of typhus fever.

W. C. Allee, professor of zoology, University of Chicago, the relationship between numbers of animals and the rate of formation of automatisms in birds; L. R. Cleveland, assistant professor of protozoology, Harvard University Medical School, cytology and hypermastigote flagellates from termites; T. D. A. Cockerell, professor of zoology, University of Colorado, the taxonomy of the bees of Africa; Emmett R. Dunn, professor of biology, Haverford College, the amphibians and reptiles of lower Central America; Raymond E. Girton, assistant professor of plant physiology, Purdue University, the respiratory activity of plant roots; P. W. Gregory, assistant professor of animal husbandry, College of Agriculture, University of California, glutathione in relation to growth and hereditary body size in the rabbit; Mary J. Guthrie, associate professor of zoology, University of Missouri, the cytology of the organs of reproduction in mammals, with special reference to bats; Herbert C. Hanson, professor of botany, North Dakota Agricultural College, methods of analyzing quantitative data in grassland investigations; Walter N. Hess, professor of biology, Hamilton College, cataract and diabetes in trout; Robert K. Nabours, professor of zoology, Kansas State College, inheritance in Orthoptera; H. D. Reed, professor of zoology, and Myron Gordon, Heckscher research assistant, Cornell University, cytological investigations of certain species of fishes; George B. Rigg, professor of botany, University of Washington, the profiles of sphagnum bogs of the Pacific Coast region; William J. Robbins, professor of botany, University of Missouri, the growth of meristems of higher plants; A. Franklin Shull, professor of zoology, University of Michigan, wing production in aphids; Septima Smith, associate professor of zoology, University of Alabama, cystocercous Cercariae; T. L. Smith, department of zoology, Columbia University, genetical studies of the wax moth, *Galleria mellonella* L.; Mary B. Stark, professor of histology and embryology, New York Homeopathic Medical College, living cancer and sarcoma cells; F. B. Sumner, professor of biology, Scripps Institution of Oceanography, University of California, effects of optic stimuli upon the hair color of mammals; Allyn J. Waterman, instructor in biology, Brooklyn College, the organization of early mammalian embryos.

Fay-Cooper Cole, professor of anthropology, University of Chicago, pictorial survey of Mississippi Valley archeology; Harry R. DeSilva, professor of psychology, Massachusetts State College, action potentials of cutaneous nerves in rats and human beings; Franklin Fearing, associate professor of psychology, Northwestern University, the vestibular function in pigeons; J. A. Ford, archeologist, Mississippi Department of Archives and History, Indian mounds and village sites in Louisiana; Walter B. Jones, director, Alabama Museum of Natural History, archeological survey of Alabama; Robert A. McKennon, instructor in sociology, Dartmouth College, ethnographic study of a Kutchin group of Athabascan Indians in Alaska; Edward Sapir, professor of anthropology, Yale University, the preparation of a grammar, a series of texts and a dictionary of the Nootka language, of Vancouver Island, B. C.; T. C. Schneirla, assistant professor of psychology, New York University, the behavior of army ants.

The National Research Council will be ready to consider further requests for research assistance this fall. Applications should be filed with the Committee on Grants-in-Aid before October 15, 1933. Action upon these applications will be taken during the latter part of December.

ISAIAH BOWMAN,
Chairman

SCIENTIFIC APPARATUS AND LABORATORY METHODS

LAMELLIBRANCH LEUCOCYTES AS LIVING MATERIAL FOR CLASSROOM DEMONSTRATION

INCIDENTAL to studies concerned with the vitality of Molluscan leucocytes *in vitro* it was noted that those of *Ostrea virginica* possessed several features especially recommending them for classroom use as demonstration material. These features were found to be also evident in Venus and Anodonta and are probably common to most other lamellibranchs.

After removing one valve, a capillary pipette may be thrust into the heart and a quantity of blood withdrawn. A single specimen will yield more than enough material for a large class. The leucocytes in a drop, when placed on a slide, contract to a spherical shape and clump together. In from five to ten minutes they begin to thrust out pseudopods and move away from each other, and will then remain active for at least several hours if the drop is sealed. Since these forms occur in a practically pure culture, if properly collected, they are particularly suited to student purposes.

If a few drops of the blood are placed in a dish of the same water from which the animals came, the leucocytes will go on living for several days without further attention.[1] As the leucocytes collect on the bottom they are readily recovered by means of a pipette when needed. The advantageous features of such material are evident and include the ease with which they are obtained, the simplicity of handling, the abundance of cells and their relative hardiness. As demonstration material they show amoeboid movement, ingestion of food, and in fact all the usual features for which free-living amoebae are customarily employed to illustrate. If left in a sealed drop of sera over night they will be found to have again contracted to a spherical form. The addition of some fresh water will revivify them a second time, at least. It seems that their length of life *in vitro* is almost directly proportional to the amount of fluid in their container.

The operative technique mentioned is not imperative, as these mollusks, if placed in a water that is allowed to warm slightly, will emit quantities of leucocytes. This is the well-known diapedesis or "bleeding" of oysters under suffocation.[2] Thus a single animal can be used repeatedly if a suitable aquarium is handy to which it may be returned. Samples taken this way frequently show contamination. For example, oysters obtained from a New York market yielded an *Amoeba* of the *limax* type from the exterior of the shell and *Valkampfia calkinski* or *V. patuxent* from the intestinal tract.[3] The latter two can be cultured easily on ordinary nutrient agar plates, yielding abundant parasitic material. Thus, such a demonstration may have a further advantage, showing on a single slide, from a single source, leucocytes, free-living and parasitic amoebae all migrated or ejected from one animal with no operative effort. Without considerable familiarity it is almost impossible to distinguish the living leucocytes from the parasitic amoebae.

Since the three genera, Ostrea, Venus and Anodonta, as well as other similar ones, are wide-spread, little difficulty should be encountered in obtaining material from various localities. The animals for most part are fairly hardy and may be kept in a suitable aquarium or obtained from a market or other sources as needed.

C. M. BREDER, JR.
NEW YORK AQUARIUM
R. F. NIGRELLI
NEW YORK UNIVERSITY

EXAMINATION OF THE REVERSE SIDE OF MICRO-MOUNTS

ONE of the greatest needs of the acarologist, and others who mount minute arthropods on microslides, is to see the other side of their specimen. To turn the slide over and look through the one to two millimeters of glass is hardly satisfactory because the objectives are corrected for cover-glass thickness. Obviously, this may be overcome by securing an objective corrected for a cover-glass thickness of one or more millimeters. To have such a lens made up in America is prohibitive. Besides, the American four-millimeter objectives have such small working distances as to strike the slide before coming into focus. Finally I discovered that W. Watson and Sons, London, stock a four-millimeter (six-inch) parachromatic objective with a long working distance and that this objective

[1] Orton (1924, Fisheries Invest. Series II, 6) reported that the leucocytes of *Ostrea edulis* will live from 3 to 4 days in a dish, while we have had those of *Ostrea virginica* live for 6 days under similar conditions.

[2] This effect has been discussed by Orton (1924) ref. cited and Yonge (1928), *Jour. Mar. Biol. Ass.*, 15. The slight provocation that will cause this response can hardly be considered suffocation in the ordinary sense and certainly must take place frequently in a state of nature.

[3] Hogue (1915), *Arch. f. Protist.*, 35 (1922), *Jour. Exp. Zool.*, 35.

could be made up corrected for glass thickness of one millimeter and a tube length of one hundred and sixty millimeters for something like $20.

Thanks to an American Association for the Advancement of Science research grant, I was enabled to secure such an objective. After trying it out for the period of a year, I am able to recommend it to my colleagues as an important aid for the detailed study of micro-mounted arthropods. The definition of the lens is as good as the four-millimeter objective used in the ordinary way, so that one side of a specimen is as easily scrutinized as the other.

The next step in improving technique is to limit microslides to a standard maximum thickness, say 1.3 millimeters. If the thickness is less, it can be compensated by placing a cover glass on the slide (held by a film of water) to make up the necessary thickness.

ARTHUR PAUL JACOT

ITHACA, N. Y.

AN INEXPENSIVE THERMO-REGULATOR

A VERY satisfactory regulator for operating a small isothermal bath may be made from an ordinary Babcock skim-milk bottle filled with mercury. One lead of wire is placed in the side tube, which is plugged with cotton and a small cork. The other lead is connected with a short piece of platinum wire supported in the capillary of the bottle. The regulator can be easily adjusted by increasing or decreasing the volume of mercury and by varying the height of the platinum wire. The accuracy of control is estimated at 0.1 degree C.

If a more accurate instrument is desired a Wagner's improved skim-milk bottle, which has a smaller capillary, may be substituted for the Babcock bottle. Either bottle may be obtained at a cost of 80 cents and holds about 50 ml of mercury.

L. L. ENGLISH

ALABAMA POLYTECHNIC INSTITUTE

SPECIAL ARTICLES

EARLY CHANGES IN THE CEREBROSPINAL FLUID OF MONKEYS NASALLY INSTILLED WITH THE VIRUS OF POLIOMYELITIS

MICROSCOPIC examination of the cerebrospinal fluid from cases of epidemic poliomyelitis in man reveals an increase in the number of the white cells present. This change in the composition of the fluid is employed as a means of arriving at a diagnosis of suspected poliomyelitis in instances in which no muscular impairment is detectable.

A similar increase in the number of white cells present in the fluid arises in monkeys (*Macacus rhesus*) in which the virus of poliomyelitis has been instilled into the nasal cavities.[1] Advantage was taken of this interesting fact to determine the relation of the increase in cells to the appearance of symptoms of infection in the monkey. The cerebrospinal fluid was withdrawn by cistern puncture, just before instillation of the virus, and at intervals of 48 hours afterwards. This interval was chosen in order to avoid too frequent puncture and to insure an adequate flow of the fluid. Two instillations of virus, consisting of a suspension of glycerolated spinal cord and medulla of monkeys succumbing to acute, experimental poliomyelitis, were made on successive days.

The preliminary cell counts of the fluid of normal monkeys gave values as low as 12, but usually of from 20 to 30 cells per cubic millimeter. At the end of the first 48 hours, an increase of cells was already apparent in some, but not in all the monkeys receiving virus by the instillation method; the cell counts were around 70. At the expiration of the second 48-hour period, the rise in the count was more general, the cells fluctuating between 100 and 300 per cubic millimeter.

Up to this time, the instilled monkeys presented no detectable signs of infection. Beyond this period, depending on the potency of the virus and the susceptibility of individual animals, symptoms consisting of fever, ataxia and muscular weakness arose; and, as a rule, the cell count increased still further with the onset of symptoms. In passing, it should be stated that globulin also appeared in the altered cerebrospinal fluid.

Hence a similarity is found to exist, in advance of all other detectable signs of infection, between the changes arising in the cerebrospinal fluid of the nasally instilled monkeys and that yielded by cases of preparalytic poliomyelitis in man. On the other hand, it is obvious that the monkey is less responsive than are children to the presence of the virus in the nervous system, since, in contrast to children, during the early or preparalytic stage of infection, the animals remain to all appearances in a normal state.

The evidence is now strong that the virus ascends from the nasal membranes to the olfactory lobes of the brain, and then continuously by nerve conduction to the midbrain and spinal cord.[2] The early involvement of the cerebrospinal fluid in the pathological process, before any systemic effects of infection ap-

[1] S. Flexner, SCIENCE, 77: 413, 1933.

[2] S. Flexner and P. F. Clark, *Proc. Soc. Exper. Biol. and Med.*, 10: 1, 1912; H. F. Faber and L. P. Gebhardt, *idem*, 30: 879, 1933; *Jour. Exp. Med.*, 57: 933, 1933.

pear, takes on, therefore, special significance for the pathogenesis of poliomyelitis in man and the monkey.

The virus has not been detected in the cerebrospinal fluid withdrawn by lumbar puncture from cases of epidemic poliomyelitis. Since the virus as originally present in human nervous tissues is of low infectivity for monkeys, the failure to induce disease in those animals by the inoculation of the fluid is not conclusive evidence of its absence from the fluid. The virus employed for the experimental, nasal instillation is highly potent for monkeys. Hence the altered cerebrospinal fluid withdrawn from the animals so inoculated was injected intracerebrally into *Macacus rhesus* monkeys, and the procedure was followed by an accelerating injection 8 days later.[3] No detectable pathological effects arose in these animals.

The conclusion to be drawn is that in man and the monkey the virus of poliomyelitis, even in small amounts, does not pass from the infected nervous tissues into the cerebrospinal fluid. The cellular changes in the fluid represent, therefore, a reaction of the nervous system to injury; they are not the result of the presence of the virus in the fluid itself.

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THE LONG AND SHORT WAVE-LENGTH LIMITS OF PHOTOSYNTHESIS

DURING the past few years we have developed a method of studying photosynthesis in various portions of the spectrum that seems to give reproducible and accurate results without interference from the secondary effects of the different wave-lengths. The method consists of a preliminary adjustment of the plant to the radiation intensity to be used. Then the actual determinations are made by exposing the plant to a steady source of one portion of the spectrum for two hours, determining the amount of carbon dioxide used, followed by exposure to such an intensity of a second portion of the spectrum that the amount of carbon dioxide used is the same as in the first case. Under these conditions the relative efficiencies of the two radiations are inversely proportional to their intensities. The advantages of this experimental procedure are that the plant is acclimated to the low radiation intensities which it receives during a determination, the exposure to an isolated portion of the spectrum is short and that, under these conditions, the amount of photosynthesis in the two determinations is probably the same.

The limits of photosynthesis were determined in the following manner. The plants were exposed to radiation well within the limits and then to radiation about half of which was within the limit and half just outside. From the relative efficiency of this latter radiation the limit was calculated on the assumptions that the limit of photosynthesis was sharp, the amount of photosynthesis was a function of the number of quanta and not of the energy of the radiation and that the quantum yield was constant. Further investigation of these points is being conducted. The table given below is typical of the results obtained with Norway spruce in determinations of the long wave-length limit.

Expt. No.	Efficiency	Experimental error
	Per cent.	Per cent.
50	40.5	16
51	41.6	5
52	40.6	4
53	44.1	6
54	46.3	4

Weighted averages of these and similar determinations gave the following results. An experimental error of 4.25 per cent. would result in an error of 50 Å.

Tree	Efficiency	Limit of photosynthesis
	Per cent.	Å
Norway Spruce I	42.8	7430
Norway Spruce II	40.5	7380
White Pine III	39.7	7340
White Pine IV	41.5	7390
Norway Spruce I	65.4	4660
Norway Spruce II	65.2	4660
White Pine I	66.1	4650
White Pine II	73.3	4490

A complete account of this work will be published elsewhere.

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[3] S. Flexner, SCIENCE, 74: 520, 1931; 77: 413, 1933.

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